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INTERNATIONAL SYMPOSIUM ON
PROBABILISTIC METHODS APPLIED TO
ELECTRIC POWER SYSTEMS
JUNE 11-13, 1986
TORONTO, ONTARIO, CANADA

Report No 86-207-K

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ABSTRACT

A brief account is given of the International Symposium on Probabilistic Methods Applied to Electric Power Systems held in Toronto, Ontario from June 11-13, 1986. The Symposium provided a forum for 180 engineers and researchers from 20 countries to present and discuss 68 technical papers in the area of applying probabilistic techniques to electrical and structural aspects of power systems. Out of 15 papers presented by Ontario Hydro engineers 12 were coauthored by professional staff from Research Division. From the feedback received from various sources and based on the assessment of the Symposium Organizing Committee it is considered that the symposium has succeeded in fulfilling its main objectives.

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740621-509-031/041	622.11	September 29, 1986	86-207-K



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EXECUTIVE SUMMARY

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Engineers are seeking improved methods for upgrading and designing electric power systems more effectively and economically without sacrificing system reliability. The one attractive alternative to the presently-used deterministic method is the probability-based method which can provide better quantitative estimates of system security level which in turn may eventually lead to more economical designs. An international symposium was organized in Toronto, Ontario from June 11-13, 1986 to provide a forum for presentation and discussion of technical developments in the area of applying probabilistic techniques to electrical and mechanical aspects of power systems. The technical contents of the symposium were selected with assistance from a technical advisory committee, representing a broad range of expertise in this field. The symposium was attended by 180 engineers and researchers from 20 countries to discuss 68 papers presented at the technical sessions. A total of 15 papers were presented by Ontario Hydro engineers out of which 12 were co-authored by professional staff from Research Division. From the feedback received from various sources and based on the assessment of the Symposium Organizing Committee it is considered that the symposium has succeeded in fulfilling its main objectives.



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To Dr. D. Mills
Director of Research

INTERNATIONAL SYMPOSIUM ON PROBABILISTIC METHODS
APPLIED TO ELECTRIC POWER SYSTEMS
JUNE 11-13, 1986
TORONTO, ONTARIO, CANADA

1.0 INTRODUCTION

An International Symposium on Probabilistic Methods Applied to Electric Power Systems was held at the Royal York Hotel in Toronto from June 11-13, 1986. The Symposium was co-sponsored by Ontario Hydro, Canadian Electrical Association, Electric Power Research Institute and the Institute of Electrical and Electronics Engineers. The objective of the International Symposium was to provide a forum for presentation and discussion of technical developments in the area of applying probabilistic techniques to electrical and structural aspects of power systems. The Symposium would be valuable to engineers involved in upgrading, designing and assessing reliability of transmission and distribution systems. The technical contents of the Symposium were selected by an international Technical Advisory Committee, representing a broad range of expertise in this field.

2.0 SYMPOSIUM ATTENDANCE

A total of 68 papers were presented at the Symposium by authors from 10 countries - Canada, USA, Brazil, Mexico, England, Germany, Japan, Australia, Poland and France - on the following technical topics:

- Analysis and Design of Transmission Systems
- System Analysis and Reliability Assessment
- Analysis, Testing and Design of Power System Components
- Data Base and Probabilistic Design/Analysis
- Power System Related Studies
- Weather Related Loads and Effects on Overhead Power Lines
- Upgrading of Existing Power Systems
- Design and Analysis of Distribution Systems
- Calibration of Power System Components

One hundred and eighty delegates from 20 countries participated in the Symposium giving a real international flavour to its proceedings. More than 50% of the delegates were from Canada with about 28% from USA and the remaining from the other 18 countries. The delegates are listed in Appendix I and a breakdown by countries is given in Table 1.

TABLE 1

ATTENDANCE AT THE INTERNATIONAL SYMPOSIUM ON
PROBABILISTIC METHODS APPLIED TO ELECTRIC POWER SYSTEMS

June 11-13, 1986
Toronto, Ontario

	<u>Registered Delegates</u>	<u>Per Cent of Total</u>
1. Canada	92	51.1
2. USA	50	27.8
3. France	5	2.8
4. Brazil	4	2.2
5. England	4	2.2
6. Mexico	4	2.2
7. Japan	3	1.7
8. India	3	1.7
9. Australia	2	1.1
10. Poland	2	1.1
11. Spain	2	1.1
12. Belgium	1	0.6
13. Finland	1	0.6
14. Holland	1	0.6
15. Italy	1	0.6
16. Norway	1	0.6
17. Taiwan	1	0.6
18. Thailand	1	0.6
19. West Germany	1	0.6
20. Yugoslavia	1	0.6
Total	180	~100

3.0 SYMPOSIUM OPENING SESSION

The Symposium was officially declared open by Mr. L.G. McConnell, Vice-President Power Systems Program Branch, Ontario Hydro. Mr. McConnell welcomed the delegates to Toronto and stressed the importance of the probability methods in solving problems related to electric power systems. He also pointed out the pioneering efforts by Ontario Hydro in developing the

probabilistic techniques and related data bases essential for effective application of these techniques.

4.0 SYMPOSIUM TECHNICAL SESSIONS

A total of 14 technical sessions were held on the topics listed on page 1 along with 2 keynote lectures on,

- i) Probabilistic Methods Used in the Assessment of Power System Reliability Evaluation

Prof. R. Billinton, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

- ii) Probabilistic Methods in Structural Design and Analysis

Prof. C.A. Cornell, Stanford University, Stanford, California, USA.

The technical program consisted of 2 1/2 days of two simultaneous sessions in the morning and in the afternoon. Each paper was allowed a total of 20 min for presentation and discussion and the attendees were encouraged to participate by submitting their discussion in writing using the forms provided at the Symposium. The written discussions and authors' replies will be published as part of the final symposium proceedings by Pergamon Press. The technical program is shown in Appendix II.

For most of the Symposium the technical presentations were kept on schedule so that the delegates who chose to attend papers in the simultaneous sessions were able to do so. The session chairmen and the presenters of the technical papers were given an opportunity to meet every morning at breakfast to discuss their respective technical programs.

The prevailing opinion of the authors, session chairman and delegates was that the 20 min time allotted for each technical presentation was in general not sufficient and should probably be increased in the future symposiums.

5.0 SOCIAL FUNCTIONS

The following three social events were organized to provide an opportunity for the delegates and guests to meet new friends and renew old acquaintances. The events also took the delegates and guests to the Ontario Hydro Research Laboratories, and Niagara Falls.

5.1 Welcoming Reception

The reception was held on June 10 between 6 and 8 p.m. and was attended by about 100 delegates and guests. Beverages and hors d'oeuvres were provided.

5.2 Symposium Banquet

A banquet was held on June 11 between 6:30 and 9:30 p.m. for all participants, spouses and guests. The guest speaker at the banquet was Mr. W. Read, President, Canadian Electrical Association, Montreal, Canada. Mr. Read spoke about the role of the Canadian Electrical Association in promoting the power industry in Canada and the need for employing new techniques such as probabilistic methods to study power system reliability.

5.3 Tour of Ontario Hydro Research Laboratories and Niagara Falls

A technical tour of the Ontario Hydro Research Division Laboratories was attended by about 100 delegates, spouses and guests. The group was welcomed by the Director of Research, Dr. D. Mills and shown a film giving an overview of the Division's activities. Various key sections of the laboratory were included in the tour. The tour was followed by a sightseeing trip to Niagara Falls including the floral clock and a dinner at the Victoria Park Restaurant facing the Falls. The outing was a pleasant change from the technical discussions and provided an opportunity, especially to the foreign delegates, to see some Canadian countryside and spend an evening visiting one of the seven wonders of the world.

6.0 CLOSING SESSION

A brief closing session was held on June 13th afternoon to officially declare the Symposium closed. It was announced at this session that the Second International Symposium on Probabilistic Methods Applied to Electric Power Systems will be held in San Francisco during the summer/autumn of 1988.

7.0 SECOND INTERNATIONAL SYMPOSIUM ON PROBABILISTIC METHODS APPLIED TO ELECTRIC POWER SYSTEMS

The Second International Symposium will be jointly organized by Electric Power Research Institute and Ontario Hydro and will be held in San Francisco in the summer or autumn of 1988. The exact date and the call for papers will be announced soon. The responsibilities of Ontario Hydro will be to organize the technical programs of the Symposium leaving all the other organizational responsibilities to EPRI.

8.0 TECHNICAL CONTRIBUTION BY ONTARIO HYDRO RESEARCH DIVISION

A total of 16 Ontario Hydro papers were presented at the Symposium of which 12 were coauthored by engineers from the Research Division:

1. Probabilistic Optimization of Transmission Line Design: J.S. Barnet, Research Division.
2. Reliability of Ontario Hydro's 500 kV Narrow Base Transmission Structures: A.P. Goel, Design and Development Division-Transmission.
3. Uplift Design of Transmission Tower Foundations in Sand - Probabilistic Approach: C.B. Craqq, S.G. Krishnasamy and H.S. Radhakrishna, Research Division.
4. Wind Direction and Extreme Design Wind Loads for Overhead Power Lines: S.G. Krishnasamy and N. Ramani, Research Division.
5. Statistical Models for Lightning Intensity and their Application to Prediction of Transmission Lightning Outage Rates: W.A. Chisholm, Research Division and D. Andrews, University of Toronto.
6. Modelling Requirements for Bulk Power System Reliability Evaluation: B. Porretta, System Planning Division.
7. Contingency Simulation and Ranking Techniques for Power System Reliability Evaluation: M.A. El-Kady, Power System Operations Division and M.S. El-Sobki and N.K. Sinha, McMaster University.
8. Clearances for Galloping on Overhead Lines: D.G. Havard and C.J. Pon, Research Division and G.S. Watt, Design and Development Division-Transmission.
9. Application of Probability Techniques to Transmission Line Upgrading: S.G. Krishnasamy and N. Ramani, Research Division and J.P. Bayne, System Planning Division.
10. Probabilistic Short-Circuit Upgrading of Station Strain Bus System - Overview, Application and Assessment: M.D. Germani, Design and Development Division-Transmission, M. Vainberg, M.A. El-Kady, G.L. Ford and R.W.D. Ganton, Research Division.
11. A Sensoring Technique in the Monte Carlo Simulation Method Applied to Probability Based Distribution Line Wood Pole Design: A. Kamarudin, Distribution Systems Division.

12. Probability-Based Design of Wood Pole Distribution Lines: S.G. Krishnasamy, Research Division, M.S. Nashid, Design and Development Division-Transmission and C.B. Xourafas, Distribution Systems Division.
13. Prediction of Distribution Line Service Reliability by Probability Methods: C.B. Xourafas, Distribution Systems Division and S.G. Krishnasamy, Research Division.
14. Statistical Analysis of Power Systems Using the Adjoint and Monte-Carlo Methods: S.L. Cress, Research Division.
15. Three State Component Representation for Reliability Evaluation of Power Systems: J.A. Buzacott, University of Waterloo and G.J. Anders, Research Division.
16. Estimation of Extreme Wind Speeds from Short Monthly Wind Records: M. Grigoriu, Cornell University, S.G. Krishnasamy, Research Division and V.J. Longo, Electric Power Research Institute.

9.0 SYMPOSIUM ORGANIZING COMMITTEE AND TECHNICAL ADVISORY COMMITTEE

The organizational and technical aspects of the Symposium were managed by a committee consisting of representatives from Ontario Hydro, Canadian Electrical Association and Electric Power Research Institute. The membership of the Organizing Committee is listed below:

ORGANIZING COMMITTEE

Samy Krishnasamy	Ontario Hydro - Chairman
Ray Del Bianco	CEA
Dick Kennon	EPRI
Dave Havard	Ontario Hydro
Craig Pon	Ontario Hydro
Chris Cragg	Ontario Hydro
Steve Cress	Ontario Hydro
Maguid Nashid	Ontario Hydro
Bob Xourafas	Ontario Hydro
Julia Morrison	Ontario Hydro-Symposium Secretary

The papers for the Symposium were chosen with assistance from an international technical advisory committee consisting of 19 members from six countries.

TECHNICAL ADVISORY COMMITTEE

Roy Billinton	University of Saskatchewan, Saskatoon, Canada
Sam Cluts	Sargent & Lundy Chicago, USA
Allin Cornell	Stanford University Stanford, USA
Tony DiGioia, Jr.	GAI Consultants Pittsburgh, USA
John Endrenyi	Ontario Hydro Toronto, Canada
Gary Ford	Ontario Hydro Toronto, Canada
Elias Ghannoum	Hydro Quebec Montreal, Canada
Bev Gill	Ontario Hydro Toronto, Canada
Jim Goodman	Colorado State University Fort Collins, USA
Ed Goodwin	Pennsylvania Power & Light Allentown, USA
Georges Henrioul	Electrobel Brussels, Belgium
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Paul Lyons	Electric Power Research Institute Haslet, USA
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Paolo Paoli	ENEL-CREL Milan, Italy
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10.0 CONCLUSIONS

The International Symposium on Probabilistic Methods Applied to Electric Power Systems was held in Toronto from June 11-13, 1986 under the co-sponsorship of Ontario Hydro, Canadian Electrical Association, Electric Power Research Institute and the Institute of Electrical and Electronics Engineers. A total of 68 papers were presented by authors from 11 countries at the Symposium which was attended by 180 delegates from 20 countries.

Since it was the first symposium to be held on the application of probabilistic methods to electric power systems, one of its main objectives was to bring together engineers and researchers involved in the analysis, design and maintenance of power systems for presentation and discussion of developments in this area. From the feedback received from various sources and based on the assessment of the Symposium Organizing Committee it is considered that the Symposium has succeeded in fulfilling the main objectives.

The Second International Symposium on Probabilistic Methods Applied to Electric Power Systems will be held in San Francisco in the summer/autumn of 1988 and will be jointly organized by EPRI and Ontario Hydro.

11.0 ACKNOWLEDGEMENTS

The Symposium Organizing Committee is very grateful for all the individuals and organizations, especially the Staff from

Mechanical Research and Divisional Services Departments, who contributed to the Symposium in making it a successful event.

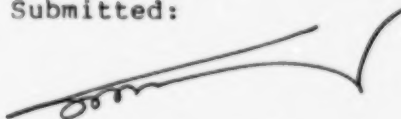
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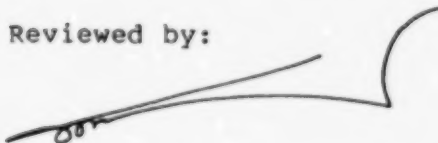
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APPENDIX I

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APPENDIX II
TECHNICAL PROGRAM OF THE INTERNATIONAL SYMPOSIUM ON PROBABILISTIC
METHODS APPLIED TO ELECTRIC POWER SYSTEMS

Wednesday, June 11, 1986

Opening Session 8:30-9:00 am

Room: Ontario

Chairman: S.G. KRISHNASAMY, Ontario Hydro, Toronto, Ontario, Canada.

Welcome Speech: L.G. McCONNELL, Vice-President, Power System Program Branch, Ontario Hydro, Toronto, Ontario, Canada.

Symposium Functions: D.G. HAVARD, Ontario Hydro, Toronto, Ontario, Canada.

Keynote Lecture-I 9:00-10:00 am

Room: Ontario

Chairman: R.A. DEL BIANCO, Canadian Electrical Association, Montreal, Quebec, Canada.

Topic: Probabilistic Methodologies used in the Assessment of Power System Reliability Evaluation *

Speaker: Prof. R. BILLINTON, Assistant Dean of Engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Coffee Break 10:00-10:15 am

Session No 1A 10:15 am-12:00 noon
ANALYSIS AND DESIGN OF TRANSMISSION SYSTEMS - I

Room: Territories

Chairman: E. GHANNOUM, Hydro-Quebec, Montreal, Quebec, Canada.

10:15 Probabilistic Optimization of Transmission Line Design: J.S. BARRETT, Ontario Hydro, Toronto, Ontario, Canada.

* Co-authored by Prof. R.N. ALLAN, University of Manchester, Manchester, England.

10:35 Structural Reliability Analysis of a Transmission Tower Using Probabilistic Finite Element Method: A.K. HALDAR, Newfoundland and Labrador Hydro, St. John's, Newfoundland, Canada.

10:55 Probabilistic Collapse Analysis of Transmission Line Structures: Y. MUROTSU, H. OKADA, S. MATSUZAKI and S. NAKAMURA, University of Osaka Prefecture, Sakai, Osaka, Japan.

11:15 Load and Resistance Factors for Structural Components: B.M. AYYUB, University of Maryland, College Park, MD and G.J. WHITE, U.S. Naval Academy, Annapolis, MD, USA.

11:35 Reliability of Ontario Hydro's 500 kV Narrow Base Transmission Structures: A.P. GOEL, Ontario Hydro, Toronto, Ontario, Canada.

Session No 1B 10:15 am-12:00 noon
SYSTEM ANALYSIS AND RELIABILITY ASSESSMENT - I

Room: British Columbia

Chairman: J. ENDRENYI, Ontario Hydro, Toronto, Ontario, Canada

10:15 Probabilistic Transmission Planning Procedures within the CEGB: S.J. ARGENT and D.P.G. HADFIELD, Central Electricity Generating Board, London, England.

10:35 A General Purpose Computer Program for the Reliability Analysis and Design of Structural Line Components: A.H. PEYROT and H.J. DAGHER, The University of Wisconsin, Madison, WI, USA.

10:55 Brazilian Experience on Probabilistic Methods Applied to Network Planning: J.C.G. PRACA and M. Th. SCHILLING, ELETROBRAS - DEST/GPD, Rio de Janeiro, Brazil.

11:15 Computer Experiments with System Reliability Methods - A Critical Study: D.M. FRANGOPOLO and R. NAKIB, University of Colorado, Boulder, CO, USA.

11:35 Probabilistic Analysis of Dynamic Short Circuit Stresses of Rigid Bus - Bars and Support Insulators Considering Reclosure: E. Mitkowski, R. Paszyk and R. Frackowiak, Technical University of Poznan, Poznan, Poland.

Lunch 12:00 Noon-1:30 pm

Room: Confederation (4, 5 & 6)

Session No 1C 1:30-3:15 pm
ANALYSIS AND DESIGN OF TRANSMISSION SYSTEMS - II

Room: Territories

Chairman: S.G. KRISHNASAMY, Ontario Hydro, Toronto, Ontario, Canada.

1:30 Practical Code Formats for Probability - Based Design of Transmission Structures: A.M. DIGIOIA, Jr., GAI Consultants, Monroeville, PA, A.H. PEYROT, University of Wisconsin, Madison, WI, J.C. POHLMAN, Pittsburgh, PA and J.D. MOZER, GAI Consultants, Monroeville, PA, USA.

1:50 Probabilistic Assessment and Design of Transmission Line Towers with Inference from Full-Scale Tests: P.Y. WANG, M. AMIN, S.J. FANG and T.M. SEKILI, Sargent and Lundy Engineers, Chicago, IL, USA.

2:10 Reliability-Based Design of Transmission Lines According to Recent Advances by IEC and GIGRE Working Groups: E. GHANNOUM, Hydro-Quebec, Montreal, Quebec, Canada.

2:30 An Introduction to the EPRI Reliability Based Design Guide: M.E. CRISWELL, M.D. VANDERBILT, J.R. GOODMAN and J. BODIG, Colorado State University, Fort Collins, CO, USA.

2:50 The NESC, Probability, Reliability and the Future: F.G. PICCIANO, N.Y. State Electricity and Gas Co., Binghamton, NY, USA.

Session No 1D, 1:30-3:15 PM
ANALYSIS, TESTING AND DESIGN OF POWER SYSTEM COMPONENTS - I

Room: British Columbia

Co-Chairmen: J. POHLMAN, Consultant, Pittsburgh, PA, USA and C.B. XOURAFAS, Ontario Hydro, Toronto, Ontario, Canada.

1:30 Probabilistic Design Methods as Applied to High Capacity Grouted Anchors: E.A. STEMSHORN, TransAlta Utilities, Calgary, Alberta, Canada.

1:50 Observations on the Variability of Undrained Side Resistance for Deep Foundations: M.J. SPRY, M. GRIGORIU and F.H. KULHAWY, Cornell University, Ithaca, NY, USA.

2:10 Uplift Design of Transmission Tower Foundations in Sand - A Probabilistic Approach: C.B. CRAGG, S.G. KRISHNASAMY, and H.S. RADHAKRISHNA, Ontario Hydro, Toronto, Ontario, Canada.

2:30 The Application of Probabilistic Methods of Increasing the Short-Circuit Stress for Selected Plants of the Transmission of Power: A. STEGEMANN and F. BERGER, VE Kombinat Verbundnetze Energie, Berlin, Germany.

2:50 Buckling Strength Prediction Equation for Angles - Probabilistic Approach: O. HERNANDEZ-BASILIO, Instituto de Investigaciones Electricas, Mexico City, Mexico.

Coffee Break 3:15-3:30 PM

Session No 1E 3:30-5:15 PM
DATA BASE AND PROBABILISTIC DESIGN/ ANALYSIS - I

Room: Territories

Chairman: P. LYONS, Electric Power Research Institute, Haslet, TX, USA.

3:30 Wind Load Data for Reliability-Based Transmission Line Design: H.S. NORVILLE, K.C. MEHTA and W.P. VANN, Texas Tech University, Lubbock, TX, USA.

3:50 Wind Direction and Extreme Wind Loads for Overhead Power Lines Design: S.G. KRISHNASAMY and N. RAMANI, Ontario Hydro, Toronto, Ontario, Canada.

4:10 Data Collection for the Bonneville Power Administration Project on Wind Loading of Transmission Conductors: H.W. VOLPE, Bonneville Power Administration, Portland, OR, USA.

4:30 Process for Determination of the Wind Load Used in Design of Transmission Tower in Japan and Problems Involved: Y. SAKAMOTO, Central Research Institute of Electric Power Industry, H. YAMAGISHI and M. NAGANO, Tokyo Electric Power Company, Tokyo, Japan.

4:50 Data Uncertainty: Evaluation, Control and Impact: R.A. LeMASTER, Sverdrup Technology, Inc., Tullahoma, TN, USA.

Session No 1F 3:30-5:15 PM
POWER SYSTEM RELATED STUDIES - I

Room: British Columbia

Chairman: D.G. HAVARD, Ontario Hydro, Toronto, Ontario, Canada.

3:30 Effect of Wind on the Minimum Flashover Voltage of Iced Insulators in Foul Weather: N. SUGAWARA, M. FARZANEH and J.L. LAFORTE, Universite du Quebec a Chicoutimi, Chicoutimi, Quebec, Canada.

3:50 A New Method for the Steady-State Solution of Complex Markov Systems: M. SCHWARZBLAT and J. ARELLANO, Instituto de Investigaciones Electricas, Cuerna Vaca, Mexico.

4:10 Statistical Models for Lightning Intensity and their Application to Prediction of Transmission Lightning Outage Rates: W.A. CHISHOLM, Ontario Hydro, W.JANISCHEWSKYJ and D. ANDREWS, University of Toronto, Toronto, Ontario, Canada.

4:30 Failure Frequency of Cables in the Mining Areas: A. SZENDZIELORZ, Silesian Technical University, Gliwice, Poland.

4:50 Probability Based Line Design - / Draft Proposal for 230 kV and Above for the Canadian Standards Association: C.I. Orde, TransAlta Utilities Co. Calgary, Alberta, Canada and B. White, Consultant, Hudson, Quebec, Canada

Thursday, June 12, 1986

Session No 2A 8:30-10:15 am
SYSTEM ANALYSIS AND RELIABILITY ASSESSMENT - II

Room: Territories

Co-Chairmen: A. PEYROT, University of Wisconsin, Madison, WI, USA and C. CRAGG, Ontario Hydro, Toronto, Ontario, Canada.

8:30 EDF Probabilistic Approach in Transmission Planning Studies - Concepts and Computation Tools for a Better Assessment of Reliability and Security of an EHV Transmission Power System: J. BATUT, Electricite de France, Clamart, Cedex, France.

8:50 Reliability Gains in Power Systems Interconnected: M. BERG, Georgia Institute of Technology, Atlanta, GA, USA and J. ZAHAVI, Tel Aviv University, Tel Aviv, Israel.

9:10 Modelling Requirements for Bulk Power System Reliability Evaluation: B. PORRETTA, Ontario Hydro, Toronto, Ontario, Canada.

9:30 Extension of Large Deviation Technique to Power System Reliability Applications: C.K. YIN and M. MAZUMDAR, University of Pittsburgh, Pittsburgh, PA, USA.

9:50 Contingency Simulation and Ranking Techniques for Power System Reliability Evaluation: M.A. EL-KADY, Ontario Hydro, Toronto and M.S. EL-SOBKI and N.K. SINHA, McMaster University, Hamilton, Ontario, Canada.

Session No 2B 8:30-10:15 am
**WEATHER RELATED LOADS AND EFFECTS ON
OVERHEAD POWER LINES**

Room: British Columbia

Co-Chairmen: J.R. GOODMAN, Colorado State University, Fort Collins, CO, USA and M.S. NASHID, Ontario Hydro, Toronto, Ontario, Canada.

8:30 Probabilistic Considerations in Transmission Line Wind Design for Mexico: J. AGUIRRE R. and J. SANCHEZ S., Instituto de Investigaciones Electricas, Mexico City, Mexico.

8:50 A Stochastic Model for Wind Induced Vibrations and Damage Accumulation in the Cables of Overhead Transmission Lines: D. HAGEDORN and J. SCHMIDT, Institut für Mechanik, Technische Hochschule Darmstadt, Darmstadt, Germany.

9:10 Electrical Transmission Structure Response to Wind: K.C. MEHTA, H.C. NORVILLE, Texas Tech University, Lubbock, TX and L. KEMPNER, Jr., Bonneville Power Administration, Portland, OR, USA.

9:30 Clearances for Galloping on Overhead Lines: D.G. HAVARD, C.J. PON and J.R. MEALE, Ontario Hydro, Toronto, Ontario, Canada.

9:50 A Probabilistic Approach for Optimal Location of Bundled Conductor Spacers to Minimize Damage from Aeolian Vibration: R.K. CHAN, Saskatchewan Power Corporation, Regina, P.R. UKRAINETZ, University of Saskatchewan, Saskatoon and D.R. NAGEL, Saskatchewan Power Corporation, Regina, Saskatchewan, Canada.

Coffee Break 10:15-10:30 am

Session No 2C 10:30 am-12:15 pm
UPRATING OF EXISTING POWER SYSTEMS

Room: Territories

Co-Chairmen: G. ORAWSKI, Balfour-Beatty, London, England and G.L. FORD, Ontario Hydro, Toronto, Ontario, Canada.

10:30 Application of Probability Techniques to Transmission Line Upgrading: S.G. KRISHNASAMY, N. RAMANI and J.P. BAYNE, Ontario Hydro, Toronto, Ontario, Canada.

10:50 The Use of Probabilistic Techniques in the Design and Upgrading of Transmission Lines in Hydro-Quebec: E. GHANNOUM, Hydro-Quebec, Montreal, Quebec, Canada.

11:10 Costs and Benefits of Probabilistic Approach to the Upgrading of 110 kV Substations with Excessive Fault Currents: J. POPCZYK and A. BLASZCZYK, Technical University of Gliwice, Gliwice, Poland.

11:30 Probability Methods for Calculating the Current Capacity of Overhead Transmission Lines: V.T. MORGAN, CSIRO, Division of Applied Physics, Sydney, Australia.

11:50 Probabilistic Short-Circuit Upgrading of Station Strain Bus System - Overview, Application and Assessment: M.D. GERMANI, M. VAINBERG, M.A. EL-KADY, G.L. FORD and R.W.D. GANTON, Ontario Hydro, Toronto, Ontario, Canada.

Session No 2D 10:30 am-12:15 pm
**DESIGN AND ANALYSIS OF DISTRIBUTION
SYSTEMS**

Room: British Columbia

Chairman: J. KORTSCHINSKI, Ontario Hydro, Toronto, Ontario, Canada.

10:30 Probability-Based Design of Wood Pole Distribution Lines: S.G. KRISHNASAMY, M.S. NASHID and C.B. XOURAFAS, Ontario Hydro, Toronto, Ontario, Canada.

10:50 Application of Probabilistic Risk Assessment Techniques to Distribution System Consideration: R.A. KRAMER, Northern Indiana Public Service Company, Hammond, IN, USA.

11:10 Evaluation of Urban Distribution Systems Reliability: J. VILAR and M. VEGA, Instituto de Investigaciones, Cuernavaca, Mexico.

11:30 Prediction of Distribution Line Service Reliability by Probability Methods: C.B. XOURAFAS and S.G. KRISHNASAMY, Ontario Hydro, Toronto, Ontario, Canada.

11:50 Statistical Analysis of Power Systems Using the Adjoint and Monte-Carlo Methods: S.L. CRESS, Ontario Hydro, Toronto, Ontario, Canada.

Lunch 12:15-1:30 pm

Room: Confederation (4, 5 & 6)

Friday, June 13, 1986

Keynote Lecture-II 9:00-10:00 am

Room: Territories

Chairman: R. KENNON, Electric Power Research Institute, Palo Alto, CA, USA.

Topic: Probabilistic Methods in Structural Design and Analysis

Speaker: Prof. C.A. CORNELL, Department of Civil Engineering, Stanford University, Stanford, CA, USA.

Coffee Break 10:00-10:15 am

Session No 3A 10:15 am-12:00 noon
ANALYSIS, TESTING AND DESIGN OF POWER SYSTEM COMPONENTS - II

Room: Territories

Co-Chairmen: P. PAOLI, ENEL-CREL, Milan, Italy and S. CLUTS, Sargent & Lundy, Chicago, IL, USA.

10:15 Surge Arrester Insulator for Transmission Line to Prevent Lightning Trip: Y. ICHIHARA, S. MORI, K. WAKAMATSU, Tokyo Electric Power Company, Tokyo, Japan.

10:35 A Centering Technique in the Monte Carlo Simulation Method Applied to Probability Based Distribution Line Wood Pole Design: A. Kamarudin, Ontario Hydro, Toronto, Ontario, Canada.

10:55 A Stochastic Method of Assessing the Effect of Joint Deformation on Bolted Lattice Towers: D.C.J. WILLIAMS, Balfour-Beatty Power Construction Ltd., Surrey, England, and I.W. BRIGHTWELL, Electricity Commission of N.S.W., Australia.

11:15 The EPRI Transmission Line Mechanical Research Facility - Lattice Tower Data Base: D. CANNON, T. THEISS and B. PEWITT, Sverdrup Technology Inc., Tullahoma, TN, USA.

11:35 Predicting Static Fatigue Strength of Non-Ceramic Suspension Insulators Using Cumulative Damage and Accelerated Life Testing: C.W. EK, Bonneville Power Administration, Vancouver, WA, USA.

Session No 3B 10:15 am-12:00 noon
POWER SYSTEM RELATED STUDIES - II

Room: British Columbia

Co-Chairmen: S.L. CRESS and C.J. PON, Ontario Hydro, Toronto, Ontario, Canada.

10:15 Multi-Area Reliability Evaluation Via a Demand-Supply Feasibility Theorem: F.N. LEE, The University of Oklahoma, Norman, OK, USA.

10:35 Characterization of the Aging of Thermal Generators for Reliability Assessment: M.Th. SCHILLING and J.C.G. PRACA, Eletrobras and J.F. De QUEIROZ, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.

10:55 Probabilistic Techniques in Load Flow Analysis - A Practical Application: A.M. LEITE DA SILVA and V.L. ARIENTI, Catholic University of Rio de Janeiro, Rio de Janeiro, Brazil.

11:15 Three State Component Representation for Reliability Evaluation of Power Systems: J.A. BUZACOTT, University of Waterloo, Waterloo and G.J. ANDERS, Ontario Hydro, Toronto, Ontario, Canada.

11:35 Probabilistic Analysis Techniques Used to Examine Ground Clearance for the

Pacific Northwest DC Intertie Upgrade:
J.L. READING, Bonneville Power Administration,
Portland, OR, USA.

Lunch 12:00 Noon-1:30 pm

Room: Confederation (4, 5 & 6)

Session No 3C 1:30-2:30 pm
DATA BASE AND PROBABILISTIC DESIGN/
ANALYSIS - II

Room: Territories

Chairman: A. DIGIOIA, Jr., GAI
Consultants, Monroeville, PA, USA.

1:30 Survival Prediction of Wood Pole
Utility Structures: J.R. GOODMAN,
J. BODIG, M.E. CRISWELL and
M.D. VANDERBILT, Colorado State
University, Fort Collins, CO, USA.

1:50 A Probabilistic and Statistical
Approach for Hardware Testing:
J.E. BEATTIE and R.K. CHAN, Saskatchewan
Power Corporation, Regina, Saskatchewan,
Canada.

2:10 Estimation of Extreme Wind Speeds
from Short Monthly Wind Records:
M. GRIGORIU, Cornell University, Ithaca,
NY, USA, S.G. KRISHNASAMY, Ontario Hydro,
Toronto, Ontario, Canada and V.J. LONGO,
Electric Power Research Institute,
Palo Alto, CA, USA.

Session No 3D 1:30-2:30 pm
CALIBRATION OF POWER SYSTEM AND
COMPONENTS

Room: British Columbia

Chairman: B. WHITE, Consultant, Hudson,
Quebec, Canada.

1:30 Calibration of Transmission Line
Structures to Establish Reliability
Levels for Future Design: E.J. GOODWIN,
Pennsylvania Power and Light Co.,
Allentown, PA, USA.

1:50 Calibration of 46 kV and 115 kV
Wood REA Structures in Southern Alabama

Reliability - Based Design Techniques
R.C. PETERS and S.C. POWELL, Burns and
McDonnell, Kansas City, MO and
L. Hilburn, Alabama Electric Cooperative
Andalusia, AL, USA.

2:10 Reliability Calibration of the NES
Rules for the Structural Design of Trans-
mission Lines: H.J. DAGHER, University
of Maine at Orono, Orono, ME, USA.

Closing Session 3:00-3:30 PM

Room: Territories

Chairman: J.A. CHADHA, Ontario Hydro,
Toronto, Ontario, Canada.

Future Symposium: R. KENNON, Electric
Power Research Institute, Palo Alto, CA,
USA.

Closing Remarks: S.G. KRISHNASAMY,
Ontario Hydro, Toronto, Ontario, Canada.